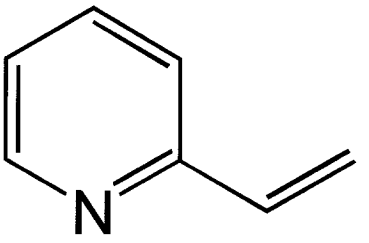
201-15018A

2-Vinylpyridine

(Chemical Abstracts Registry Number: 100-69-6)



Test Plan
HPV Chemical Challenge
December 30, 2003

Submitted by:

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Executive Summary

2-Vinylpyridine (CAS# 100-69-6) is a chemical intermediate used solely by the chemical industry for various purposes; the majority of the material is used by the tire industry. As such, it is not expected to be an exposure concern to the general public. 2-Vinylpyridine is a reactive monomer that is sold with an inhibitor incorporated to reduce the risk of hazardous autopolymerization.

A significant amount of data already exists regarding the hazards of 2-Vinylpyridine. It is known to be corrosive to tissues, flammable, and acutely toxic by oral and dermal routes. It has an extremely low odor threshold and a strongly disagreeable odor. The weight of the evidence from genetic toxicity testing shows that 2-Vinylpyridine is not mutagenic, but does cause toxicity to bacterial test systems at higher doses. Cytotoxicity is also likely to be the cause of lack of biodegradation in non-acclimated systems. 2-Vinylpyridine is not expected to bioaccumulate, nor is it expected to exhibit significant toxicity to aquatic systems.

Repeated dose testing has shown that rats administered 2-Vinylpyridine by oral gavage developed clear irritation, cell proliferation and thickening of the tissues in the forestomach, the site of contact of the test material. No systemic effects were noted through histological analysis, and body weight differences observed during the test were shown to be reversible after a recovery period.

Reilly Industries proposes to conduct aquatic toxicity testing and developmental toxicity testing on 2-Vinylpyridine, to better define these endpoints.

Data Availability Summary Table

CAS#: 100-69-6 2-Vinylpyridine	Information Available? Y/N	GLP Y/N	OECD Study Y/N	Other Study Y/N	Estimation Method Y/N	Acceptable? Y/N	Testing Required? Y/N	Notes
Physical/Chemical Endpoints								
Melting Point	Y	N	N	N	Y	Y	N	
Boiling Point	Y	NS*	N	Y	N	Y	N	
Vapor Pressure	Y	N	N	N	Y	Y	N	
Partition Coefficient	Y	NS	Y	N	N	Y	N	
Water Solubility	Y	NS	N	Y	N	Y	N	
Environmental Fate and Pathway Endpoints								
Photodegradation	Y	NS	N	Y	N	Y	N	
Stability in Water	Y	N	N	N	Y	Y	N	
Transport & Distribution	Y	N	N	N	Y	Y	N	
Biodegradation	Y	NS	Y	N	Y	Y	N	
Ecotoxicity Endpoints								
Acute Fish	Y	N	N	N	Y	N	Y	OECD 203
Acute Invertebrate	Y	NS	N	Y	N	N	Y	OECD 202
Acute Algae	Y	N	N	N	Y	N	Y	OECD 201
Toxicology Endpoints								
Acute Mammalian	Y	Y	Y	Y	N	Y	N	
Repeated Dose	Y	Y	Y	Y	N	Y	N	
Genetic Toxicity (in vitro)	Y	Y	Y	Y	N	Y	N	
Genetic Toxicity (in vivo)	Y	NS	Y	Y	N	Y	N	
Reproductive	Y	Y	Y	Y	N	Y	N	
Developmental	N	N	N	N	N	N	Y	OECD 421 (oral)

* NS = not stated

Background Information

2-Vinylpyridine is a specialty chemical intermediate manufactured and used solely in industrial settings. It has no direct consumer uses whatsoever. The vast majority of 2-Vinylpyridine manufactured in the United States (> 90%) is used in the production of tire cord and belt adhesives[1], with smaller quantities being used in the manufacture of pharmaceuticals. 2-Vinylpyridine can be polymerized to form products useful as catalysts, acid scavengers, ion-exchange resins and polyelectrolytes.[2]

2-Vinylpyridine is a reactive molecule and is sold with an inhibitor incorporated to reduce the risk of uncontrolled auto-polymerization. Reilly's handling recommendations for 2-Vinylpyridine include storage at reduced temperatures to prevent product quality problems resulting from this relatively slow auto-polymerization reaction.

2-Vinylpyridine is classified as a toxic, corrosive, flammable liquid. It has a pungent, disagreeable odor that is detectable at less than 1 ppm by volume in air.[3] Some reports suggest that 2-Vinylpyridine may be a skin sensitizer in certain individuals. Due to its classification and strong odor, 2-Vinylpyridine is handled only in closed systems with good ventilation. The strong, disagreeable odor acts as a natural action limit, but odor detection cannot be completely relied upon for exposure protection due to the potential for olfactory fatigue to occur. No occupational exposure limits for 2-Vinylpyridine are known to exist at this time.

The following is a review of the available literature on the physical/chemical properties, environmental, ecological and toxicological effects of 2-Vinylpyridine. Appendix A includes a detailed bibliography of the literature reviewed in this project, while Appendix B summarizes the reliable studies that address endpoints of the Screening Information Data Set (SIDS) under the Existing Chemicals program of the Organization for Economic Cooperation and Development (OECD).

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[1] Tire cord adhesive technology is well known, and a review may be found in the chapter entitled "Tire Cord" in the following: Bhakuni, RS; Chawla, SK; Kim, DK; Shuttleworth, D. In *Kirk-Othmer Encyclopedia of Chemical Technology;* 4th edition; John Wiley & Sons: New York, NY, 1997; Vol. 24 (Thioglycolic Acid to Vinyl Polymers), pp. 161-186.

[2] Khan, IM. In *Encyclopedia of Polymer Science and Engineering;* John Wiley & Sons: New York, NY, 1989; Vol. 17 (Transitions and Relaxations to Zwitterionic Polymerization), pp. 567-578.

[3] Trochimowicz, HJ; Kennedy, GL; Krivanek, ND. In *Patty's Industrial Hygiene and Toxicology;* Clayton, GD et al; 4th edition; Toxicology, Part E; John Wiley & Sons: New York, NY,1994; Vol. II, pp. 3360-3364.

Discussion of Data Availability

Introduction

In order to assess the reliability of the data found for 2-Vinylpyridine, the method described in Klimisch et al[4] was followed; that is, study reports were evaluated and scored using the following system:

Klimisch Code	Reliability Category	Examples
1	Reliable without restriction	• Guideline study (OECD, etc.) • Comparable to guideline study • Test procedure according to national standards
2	Reliable with restrictions	• Acceptable, well-documented publication / study report which meets basic scientific principles • Basic data given; comparable to guidelines / standards • Comparable to guideline study with acceptable restrictions
3	Not reliable	• Method not validated • Documentation insufficient for assessment • Does not meet important criteria of today standard methods • Relevant methodological deficiencies • Unsuitable test system
4	Not assignable	• Only short abstract available • Only secondary literature (review, tables, books, etc.)

Only studies with a Klimisch score of 1 or 2 were used to develop the robust summaries for 2-Vinylpyridine, which may be found in Appendix B. Modeled data, using models recommended for use by EPA, was considered to have a Klimisch score of 2.

Physical/Chemical Properties

Under ambient conditions, 2-Vinylpyridine is a colorless liquid with a pungent, disagreeable odor. The melting point of 2-Vinylpyridine is estimated to be –15°C. This modeled endpoint is consistent with Reilly's experience in handling this material; Reilly recommends that 2-Vinylpyridine be stored at temperatures below –5°C to ensure maintenance of product quality by inhibiting formation of polymers during storage. EPA guidance states that melting points less than 0°C do not need to be further specified.[5]

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[4] Klimisch, H-J; Andreae, M; Tillmann, U. *Regulatory Toxicology and Pharmacology*. **1997,** *25,* 1-5.

[5] U.S. Environmental Protection Agency. *Determining the Adequacy of Existing Data*, 10 February 1999 draft, available at http://www.epa.gov/chemrtk/datadfin.htm.

The boiling point of 2-Vinylpyridine (159.5°C) is available from a reliable reference book, summarized in Appendix B. A wide selection of boiling points at reduced pressures was found in the Beilstein database, and this data was used to calculate the vapor pressure of 2-Vinylpyridine at 25°C, using appropriate estimation calculations.[6] The mean vapor pressure result determined from these data points was 2.45 mm Hg (0.34 kPa) at 25°C. This correlates very well with the modeled vapor pressure (2.57 mm Hg) from the MPBPWIN™ module of the EPI Suite™ modeling software[7], as shown in Appendix B.

The octanol/water partition coefficient (log Kow) for 2-Vinylpyridine is 1.54, an experimental value. Based on this low value, bioaccumulation of 2-Vinylpyridine is not expected to occur. 2-Vinylpyridine is highly water soluble (2.75 g/100 mL at 20°C), further supporting the conclusion that 2-Vinylpyridine is not likely to bioaccumulate due to its tendency to migrate to the aqueous phase.

Environmental Fate and Pathways

An extensive study on 2-Vinylpyridine photodegradation pathways is summarized in Appendix B. The study concludes that 2-Vinylpyridine reacts with hydroxyl and nitrate radicals and ozone to form primarily 2-pyridinecarboxaldehyde; this indirect photolysis reaction is analogous to the photochemical breakdown of styrene to benzaldehyde, a well-known atmospheric fate pathway. For ambient atmospheric conditions, the calculated lifetime of 2-Vinylpyridine due to reaction with hydroxyl radicals, nitrate radicals and ozone is approximately 3 hours, 4 hours and 1 day, respectively. The study further states that the removal of 2-Vinylpyridine with gaseous nitric acid may be competitive with the above reactions as an atmospheric loss process.[8]

Hydrolysis is a potentially important environmental fate pathway for a range of organic chemicals, including alkyl halides, amides, amines, carbamates, epoxides, nitriles and esters. 2-Vinylpyridine does not contain a functional group that is susceptible to hydrolysis; in fact, alkenes are known to be generally resistant to hydrolysis.[9] As expected, attempts to model a hydrolysis rate using the HYDROWIN™ modeling program were unsuccessful.

2-Vinylpyridine was reportedly resistant to biodegradation over a 4-week period in a single aerobic screening test. Modeling of this endpoint using the BIOWIN™

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[6] Lyman, WJ; Reehl, WF; Rosenblatt, DH. *Handbook of Chemical Property Estimation Methods; Environmental Behavior of Organic Compounds;* McGraw-Hill: New York, NY, 1982; Chapter 14: "Vapor Pressure".

[7] U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Center. Copyright 2000. *EPI Suite*™, version 3.11, including MPBPWIN, version 1.41, released June 10, 2003. (http://www.epa.gov/opptintr/exposure/docs/episuite.htm.)

[8] Tuazon, EC; Arey, J; Atkinson, R; Aschmann, SM. *Environ Sci Technol.* **1993,** *27,* 1832-1841.

[9] Lyman, WJ; Reehl, WF; Rosenblatt, DH. *Handbook of Chemical Property Estimation Methods; Environmental Behavior of Organic Compounds;* McGraw-Hill: New York, NY, 1982; Chapter 17: "Rate of Hydrolysis".

software model also suggests that 2-Vinylpyridine may not biodegrade rapidly. This result is not unexpected, as genetic toxicity testing using bacterial systems showed that 2-Vinylpyridine exhibits substantial cytotoxicity to microbes (see Appendix B); a similar cytotoxic effect in biodegradation microbes may cause inhibition of rapid biodegradation. However, Reilly's experience has been that activated sludge biosystems used for wastewater treatment, once adequately acclimated to pyridines, can degrade 2-Vinylpyridine.

Transport and distribution of 2-Vinylpyridine in the environment were predicted using Level III fugacity modeling included in the EPI Suite™ software package. User-input parameters and emission rates are detailed in Appendix B. The model was run with the default model emission value (1000 kg/hr) for air emissions, but changing the default emission values for soil and water to zero; these changes were made due to the fact that EPA waste regulations prohibit the disposal of liquids in landfills, thus limiting potential for soil emissions (except in a spill event), and that water emissions of any magnitude are unlikely due to potential for toxicity to biotreatment systems and industrial effluent permits limiting the amount of organics that can be present in wastewater. The results of this fugacity modeling are:

Air:	79.6%
Water:	13.7%
Soil:	6.59%
Sediment:	0.0296%

Ecotoxicity

Ecotoxicity data was estimated using EPA's ECOSAR™ modeling software.[10] Predicted LC_{50} and EC_{50} values are presented in Appendix B, and are summarized as follows (rounded to the nearest whole number):

Parameter	Predicted value
Fish LC_{50} (14-day)	355 mg/L
Fish LC_{50} (96-hr)	211 mg/L
Fish LC_{50} (96-hr, SW)	39 mg/L
Fish ChV (30-day)	25 mg/L
Daphnid LC_{50} (48-hr)	219 mg/L
Daphnid EC_{50} (16-day)	9 mg/L
Green Algae EC_{50} (96-hr)	133 mg/L
Green Algae ChV (96-hr)	10 mg/L

[10] Cash, G; Nabholz, V. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Risk Assessment Division. Copyright 2001. *ECOSAR™ Classes for Microsoft Windows*, version 0.99g, released April 2001.(http://www.epa.gov/oppt/newchems/21ecosar.htm.)

A TETRATOX test was also found in the literature and the results are presented in Appendix B. Based on this data, substantial toxicity to fish, aquatic invertebrates and algae is not expected; however, the available data is admittedly limited. No data for a suitable chemical analog was available for comparison to modeled data.

Mammalian Toxicity

2-Vinylpyridine has been shown, both in laboratory testing and through human experience[11], to be strongly irritating or corrosive to tissues. Acute oral and dermal toxicity testing results show 2-Vinylpyridine is toxic by ingestion and dermal exposure, and absorption through intact skin has been noted. 2-Vinylpyridine has been shown through laboratory testing to be a potential skin sensitizer in humans, and indeed, anecdotal evidence of human exposures to vinylpyridines available in the literature supports this conclusion.[12] No inhalation toxicology information is currently available. Robust summaries for all reliable studies may be found in Appendix B.

Several reliable studies are available regarding the genetic toxicity of 2-Vinylpyridine, and robust summaries are available in Appendix B. In nearly all studies, toxicity to the test system was reported at high doses. A mammalian cell cytotoxicity assay showed that 2-Vinylpyridine caused more cytotoxicity to Chinese hamster ovary cells than did pyridine or 4-methylpyridine, but was an order of magnitude less cytotoxic than 4-vinylpyridine; the authors suggest that the increased cytotoxicity of vinylpyridines may be due to the reactivity of the vinyl group to cellular proteins and DNA.[13] Out of three reliable Ames tests reported in the literature, all were negative for mutagenicity in *Salmonella typhimurium*, both with and without metabolic activation. A reverse mutation assay using *Escherichia coli* showed a dose-response related increase in mutagenic activity in the presence of metabolic activation; no mutagenic activity was observed when metabolic activation was absent. A DNA repair assay in rat hepatocytes showed no genotoxic activity. A mammalian cell chromosomal aberration study showed a positive, dose-dependent response; however, toxicology texts warn that cytotoxicity may influence chromosomal aberration assays, giving artifactual positive responses.[14] Finally, an *in vivo* mouse lung adenoma assay conducted in A/J mice showed 2-Vinylpyridine as non-genotoxic

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[11] Stone, CA; Dunn, K. *Burns.* **1996**, *22(2)*, 150-151.

[12] a) Alarie, Y; Schaper, M; Nielsen, GD; Abraham, MH. *Arch. Toxicol.* **1998,** *72,* 125-140.
b) Sasseville, D; Kwong, P; Yu, K. *Contact Dermatitis*, **1998,** *38,* 212-214.
c) Sasseville, D; Balbul, A; Kwong, P; Yu, K. *Contact Dermatitis*, **1996,** *35,* 100-101.

[13] Bombick, DW; Doolittle, DJ. *In Vitro Toxicology*. **1995,** *8(4)*, 349-356.

[14] "Questionable positive results have been found at high chemical concentrations where osmolality may cause apparent genotoxic effects. Similarly, assays at highly cytotoxic doses and pH extremes warrant careful scrutiny, as do metabolic activation systems that may be genotoxic." From *Casarett & Doull's Toxicology: The Basic Science of Poisons*, Klaassen, CD, ed. 5th edition; McGraw-Hill: New York, NY, 1996; p. 283.

and non-tumorigenic. Based on the available data, the weight-of-evidence indicates that 2-Vinylpyridine is negative for mutagenic activity.

Three reliable, oral gavage repeat dose studies in rats are summarized in Appendix B. A 17-day study was conducted, presumably as a range-finding study in preparation for conduct of a 90-day study, which is also reported. The 17-day study concluded that the no observable effect level (NOEL) was less than 80 mg/kg, and that the site of toxic action was the non-glandular portion of the stomach (site of contact), and possibly the liver and central nervous system. The subsequent 90-day study conducted by the same laboratory did not specifically report a NOEL value, but the report indicates that no significant changes in either sex were observed at the low dose (20 mg/kg/day). Higher doses (60 and 180 mg/kg/day) resulted in reductions in weight gain and feed consumption, with a slight increase in platelet counts and a slight decrease in aspartate aminotransferase in males. Absolute and relative organ weights were affected in some cases, and the 180 mg/kg/day group showed clear irritation of the non-glandular stomach epithelium, characterized by degeneration, hyperkeratosis and acanthosis resulting in a thickening of the non-glandular epithelium.

The third repeat dose study over 28 days revealed similar findings, primarily the presence of squamous hyperplasia and submucosal edema in the forestomach in rats dosed at 50 mg/kg/day and higher. Erosion and cellular infiltration in the forestomach was also observed in males receiving 200 mg/kg/day. Reversible changes in body weight gain, food consumption, urine specific gravity and volume, and absolute and relative organ weight differences were also observed, which resolved by the end of the 14-day recovery period. The NOEL was reported to be 12.5 mg/kg/day for both sexes.

Based on the repeated dose studies available, the weight-of-evidence indicates that 2-Vinylpyridine causes primarily localized effects to the stomach due to its strongly irritating properties. While a suggestion of systemic toxicity to liver and central nervous system was noted in the 17-day range-finding study, nothing in the 28-day or 90-day studies indicated that systemic toxicity of any kind was observed, other than relative organ weight changes that were shown to be reversible in the recovery period included in the 28-day study.

The 90-day repeat dose study mentioned above includes detailed pathology examinations of reproductive organs of both males and females. Relative weight differences in testes and ovaries were observed among high dose groups, but no effects were observed upon gross pathology and histological examination. This detailed examination of reproductive organs meets the requirements for SIDS/HPV reproductive screening.

No developmental toxicity data was found for 2-Vinylpyridine.

Proposed Test Plan

Physical/Chemical Endpoints

Experimental data is available for the boiling point, partition coefficient and water solubility of 2-Vinylpyridine. The melting point of 2-Vinylpyridine is less than 0°C, and according to EPA guidance, further refinement of the melting point is unnecessary for purposes of the HPV Challenge Program. Vapor pressure data was derived using acceptable modeling software, and this modeled endpoint was further substantiated by extrapolation of vapor pressure from a collection of twenty boiling points at reduced pressure.

Conclusion: No further testing is necessary for physical/chemical endpoints of 2-Vinylpyridine.

Environmental Fate and Pathway Endpoints

Experimental data is available for photodegradation of 2-Vinylpyridine, and basic chemistry principles show that there is no potential for hydrolysis. Fugacity modeling is available to model the distribution of 2-Vinylpyridine in the environment, using the assumption that emission rates would be the same between air, water and soil. Aerobic biodegradation screening test results indicate that 2-Vinylpyridine is likely not readily biodegraded; this agrees with modeled data, and the fact that cytotoxicity is often seen upon contact with bacterial systems (as seen in genetic toxicity assays).

Conclusion: No further testing is necessary for environmental fate and pathway endpoints.

Ecotoxicity Endpoints

Modeled data suggests that substantial toxicity to fish, aquatic invertebrates and algae is not expected. However, there was no data on a chemical analog to lend support to these modeled endpoints.

Conclusion: Reilly proposes to sponsor acute fish (OECD 203), acute daphnia (OECD 202) and acute algae (OECD 201) testing for 2-Vinylpyridine.

Mammalian Toxicity Endpoints

Adequate data exists to characterize the acute toxicity of 2-Vinylpyridine. Several reliable genetic toxicity tests are available; the weight of the evidence shows that 2-Vinylpyridine is negative for mutagenic activity. Three reliable repeat dose studies are available for 2-Vinylpyridine administered by oral gavage in rats; one study reports a NOEL value of 12.5 mg/kg/day. All studies agreed that the site of toxic effect was the forestomach epithelium (site of contact of the test substance) where squamous hyperplasia was found. Statistically significant

differences in relative organ weights were found in these studies, but these differences resolved over a 14-day recovery period in the 28-day study. Detailed histopathological examination of tissues and organs revealed no statistically significant differences between test subjects and controls in the 90-day study. The reproductive endpoint is fulfilled by the complete histological examination of reproductive organs from the 90-day study; again, no statistically significant differences compared to controls were found. No data was found regarding the developmental effects of 2-Vinylpyridine.

Conclusion: Reilly proposes to sponsor an oral developmental study for 2-Vinylpyridine. For purposes of animal welfare, Reilly proposes to conduct the OECD 421 reproductive/developmental screening assay, as opposed to using the traditional OECD 414 developmental test method. This will reduce animal usage by 50%.[15] *This testing will also provide additional data for the reproductive toxicity endpoint, further supporting the conclusion that this endpoint has been adequately addressed.*

[15] U.S. Environmental Protection Agency. *HPV Chemical Human Health Testing: Animal Welfare Issues and Approaches*, **1998**, available at http://www.epa.gov/chemrtk/humnanml.pdf.

Appendix A – Bibliography

The following bibliography includes all of the studies reviewed for reliability in this data analysis, including those with Klimisch scores of 3 and 4, which were not used to develop robust summaries due to study deficiencies or lack of reported detail; such studies may be useful as supporting information.

Citation	Klimisch Score
Alarie, Y; Schaper, M; Nielsen, GD; Abraham, MH. *Archives of Toxicology.* **1998,** *72(3),* 125-140.	4
Anonymous. *Basic Toxicity of 2-Vinylpyridine.* **1983.** Eastman Kodak Company, Corporate Health and Environment Laboratories. As submitted to USEPA under TSCA §8(e) Compliance Audit Program agreement by Eastman Kodak Company, 1992, OTS#0546362.	2
Barr, K; Wnorowski, G. *DOT Skin Corrosion,* Study #T-2927. **1994.** Product Safety Labs, East Brunswick, NJ, unpublished.	2
Beilstein Database, 2003, produced by BEILSTEIN Chemiedaten GmbH, Frankfurt, Germany. Access provided by STN International, Chemical Abstracts Service, Columbus, Ohio. (Found at http://www.cas.org.)	2
Bombick, DW; Doolitle, DJ. *In Vitro Toxicology.* **1995,** *8(4),* 349-356.	2
Brunnemann, KD; Rivenson, A; Cheng, SC; Saa, V; Hoffmann, D. *Cancer Lett.* **1992,** *65(2),* 107-113.	2
Bukhalovskii, AA; Bitkina AV. *Gigiena I Sanitariya.* **1992,** *57(9-10),* 64.	4
Bukhalovskii, AA; Shugaev, BB. *Sb. Nauchn. Tr. – Nauchno-Issled Inst Monomerov Si.* **1983,** *5,* 81-5.	4
Biodegradation and Bioaccumulation Data of Existing Chemicals Based on the CSCL Japan, Chemicals Inspections and Testing Institute. Japan Chemical Industry Ecology-Toxicology and Information Center, Japan. 1992. (ISBN 4-89074-101-1) As referenced in *Hazardous Substances Data Bank®,* National Library of Medicine, Bethesda, MD. Found at http://toxnet.nlm.nih.gov/.	2
Chemicals Inspections and Testing Institute. 1992. *Biodegradation and Bioaccumulation Data of Existing Chemicals Based on the CSCL Japan.* Japan Chemical Industry Ecology-Toxicology and Information Center. ISBN 4-89074-101-1, Japan. As referenced in *Hazardous Substances Data Bank®,* National Library of Medicine, Bethesda, Maryland, USA. Found at http://toxnet.nlm.nih.gov/.	2
CRC Handbook of Chemistry and Physics; Lide, David. R., ed. 80th edition; CRC Press, Boca Raton, FL, 1999.	2
Dukhovnaia, AI. *Gigiena Truda I Professional'nye Zabolevaniya.* **1966,** *10(3),* 9-13.	4
Farago, S; Aldea, M. *Revistade Chimie (Bucharest).* **1989,** *40(2),* 166-70.	3
Fedorowicz, A; Zheng, L; Singh, H; Demchuk, E. *9th Electronic Computational Chemistry Conference,* **2003**, 1-9 (http://eccc9.cooper.edu).	4

Fitzgerald, G. B. *Acute dermal toxicity study (single exposure), amended report.* Report number 92G-0361. **1994.** Toxikon Corp., Woburn, MA..	1
Goe, GL. *Kirk-Othmer Encycl Chem Tech.* **1982,** *19,* 454-83.	2
Hawley's Condensed Chemical Dictionary; Lewis, Richard J., Sr., ed. 13th edition; John Wiley & Sons: New York, NY; 1998.	2
Henry, JE. *Rabbit skin absorption (ALD) with pyridine, 2-ethenyl-, with cover letter.* **1981.** Haskell Laboratories. As submitted to USEPA under TSCA §8(e) Compliance Audit Program agreement by DuPont Chemical, 1992, OTS#0571402.	2
Kurlyandsky BA; Rotenberg YuS; Zav'ialov NV. *Gigiena I Sanitariya.* **1974,** *39(4),* 86-89.	4
Kurlyandsky, BA.; Mashbits, FD.; Eizengart, RS. *Gigiena Truda I Professional'nye Zabolevaniya.* **1966,** *10(11),* 44-49.	4
Lange's Handbook of Chemistry; Dean, John A., ed. 14th edition; McGraw-Hill: New York, NY, 1992.	2
Lyman, WJ; Reehl, WF; Rosenblatt, DH. *Handbook of Chemical Property Estimation Methods; Environmental Behavior of Organic Compounds*; McGraw-Hill: New York, NY, 1982.	2
Marhold, J. *Prehled Prumyslove Toxikologie; Organicke Latky.* **1986,** *845.* As referenced in *Registry of Toxic Effects of Chemical Substances®,* National Institute of Occupational Safety & Health, Washington, DC.	4
Nakajima, Madoka, et al. *In vitro chromosomal aberration test of 2-vinylpyridine on cultured Chinese hamster cells.* Biosafety Research Center, Foods, Drugs and Pesticides (An-pyo Center), Japan, 582-2 Shioshinden Arahama, Fukude-cho, Iwata-gun, Shizuoka, 437-12, Japan. (Located at Japan's Global Information Network on Chemicals, found at http://wwwdb.mhlw.go.jp/ginc/dbfile1/paper/paper100-69-6f.html.)	1
Nakajima, Madoka, et al. *Reverse mutation test of 2-vinylpyirdine on bacteria.* Biosafety Research Center, Foods, Drugs and Pesticides (An-pyo Center), Japan, 582-2 Shioshinden Arahama, Fukude-cho, Iwata-gun, Shizuoka, 437-12, Japan. (Located at Japan's Global Information Network on Chemicals, found at http://wwwdb.mhlw.go.jp/ginc/dbfile1/paper/paper100-69-6e.html.)	1
Oba, Kousuke, et al. *Twenty-eight day repeat dose oral toxicity test of 2-vinylpyridine in rats.* Biosafety Research Center, Foods, Drugs and Pesticides (An-pyo Center), Japan, 582-2 Shioshinden Arahama, Fukude-cho, Iwata-gun, Shizuoka, 437-12, Japan. (Located at Japan's Global Information Network on Chemicals, found at http://wwwdb.mhlw.go.jp/ginc/dbfile1/paper/paper100-69-6b.html.)	1
Ruth, JH. *Am. Ind. Hyg. Assoc. J.* **1986,** *47,* A142-51. As referenced in *Hazardous Substances Data Bank®,* National Library of Medicine, Bethesda, Maryland, USA. Found at http://toxnet.nlm.nih.gov/.	2
Sasseville D, Kwong P, Yu K. *Contact Dermatitis.* **1998,** *38(4),* 212-214.	4

Sasseville, D; Balbul, A; Kwong, P; Yu, K. *Contact Dermatitis.* **1996,** *35(2),* 100-125.	4
Scriven, EFV; Toomey, JE; Murugan, R. 1996. "Pyridine and Pyridine Derivatives" in Kirk-Othmer *Encyclopedia of Chemical Technology*, 4th Edition, "Volume 20, Power Generation to Recycling, Glass"; John Wiley & Sons: New York, NY.	2
Seward, JR; Cronin, MTD; Schultz, T. *SAR and QSAR in Environmental Research.* **2001,** *11(5-6),* 489-512.	2
Simmon VF, Baden JM. *Mutat Res.* **1980,** *78(3),* 227-232.	1
Stone, CA; Dunn, K. *Burns.* **1996,** *22(2),* 150-1.	4
Trochimowicz, HJ; Kennedy, GL; Krivanek, ND. In *Patty's Industrial Hygiene and Toxicology;* Clayton, GD et al; 4th edition; Toxicology, Part E; John Wiley & Sons: New York, NY, 1994; Vol. II, pp. 3360-3364.	2
Tuazon, EC; Arey, J; Atkinson, R; Aschmann, SM. *Environ Sci Technol.* **1993,** *27(9),* 1832-41.	2
U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Risk Assessment Division. Copyright 2001. *ECOSAR™ Classes for Microsoft Windows*, version 0.99g, released April 2001. (Found at http://www.epa.gov/oppt/newchems/21ecosar.htm.)	2
U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Center. Copyright 2000. *EPI Suite™*, version 3.11, released June 10, 2003. (Found at http://www.epa.gov/opptintr/exposure/docs/episuite.htm.)	2
Vlaovic, Milan S. *Subchronic Oral Toxicology of 2-Vinylpyridine.* **1984.** Eastman Kodak Company, Toxicological Sciences Section, Health and Environment Laboratories. As submitted to USEPA under TSCA §8(e) Compliance Audit Program agreement by Eastman Kodak Company, 1992, OTS#0546362.	1